Cell membranes are an integral part of all living organisms. Even though each membrane-type is unique, all share striking similarities in composition, morphology, chemistry, and physical characteristics.

The most obvious purpose of the biomembrane is compartmentation. It is this barrier which sequesters the living, metabolizing protoplasm from the external environment. When we chemically degrade the membrane of the erythrocyte, for example, the cell substance simply spills out into the aqueous surroundings. Compartmentation is only one of many varied and elegant functions which can be ascribed to membranes, yet clearly illustrates its vital role in all living cells.

The evolution of the membrane as a function of the history of life itself is one of interest. Who came first, the cell or the membrane?

Although speculations on the subject cannot be verified, it still carried implications concerning the attempt to reconcile biological structure in terms of function[1]? If, indeed, the cell came first and the membrane later developed, perhaps the membrane can be described as an organelle which developed in order to fulfill certain functions. However, it could be that instead of being the result of biological development, some form of primitive membrane was a motive force for the development of life itself. If the membrane was a morphological precursor in prebiological systems, our appreciation of its universal biological presence takes on a different light. The universal existence of the membrane has an altogether different context.

1. Attempts to explain structure in terms of function are numerous. For example Albert Lehninger writes

One view —

Most biologists today think of structure in terms of function, especially on the microscopic level. While the cell is an integral whole, each part dependent on others, certain organelles carry out different biological activity. Since these activities are necessary for cell viability, the raison d'etre of all cell components down to the molecular level can be envisaged as fulfilling the varied ~~fxxxxx~~ and specailized functions on which the metabolism depends.

This view is easily applied to the membrane. The biological activities which are carried out by membranes are easily seen to be essential; ~~xxxxxxxxxx~~ These roles explain the existence as well as the ubiquity of the membrane in the cell. Were there no use, for it, it would have ~~xxxxx~~ undergone evolutionary decay, and final disappearance.

The similarities in the composition of most membranes is seen to be one of evolutionary development. Perhaps primitive organisms developed different means of self-enclosure. Some may have had cellophane membranes, for all we know. But over the eons of evolutionary development, the lipid-protein membrane evolved as the best morphological answer to cell problems of compartmentation and permeability. Whether or not different organisms at different times developed this same basic form is irrelevant. What is important is that only one type of membrane has survived to present*. This in turn indicates that it is the only one which was*fit for the job. Perhaps cells that developed high polymer membranes (such as cellophane, or polyethylene) found them too flexible, unable to carry out efficient pinocytosis and phagocytosis. The result was that these organisms were selected against.

The main criticism of the orthodox view of membrane development as a function of function is the development process itself. What type of organelle provided compartmentation previous to the development of the lipid-protein membrane?

Although ~~xxxxx~~ bacteria are capble of building sugar polymers from monomers, ~~xxx~~ and build up salt granules from aqueous ions, and even growing new flagellae, there is no known example of a case where a cell can create a membrane. While cells do synthesize specific membranal proteins and lipids, which then undergo incorporation into the membrane, the result is the growth of existing membranes. When membrane-bound organelles, such as glyoxysomes, are created in the cell, they are released as vesicles which bud from the Golgi apparatus, itself a folded membrane. Why must cells use membranes to create other membranes? The most obvious answer is that they lack the ability to organize synthesized lipids and proteins into a membrane structure, so instead, incorporate them into an already-existing one.

*Expand on this. Who says only one kind of membrane.

*and still is

Perhaps living organisms were indeed able at some time to synthesize membranes de novo, but having done so, lost the need and eventually the genetic capacity for doing so. It is unreasonable, however, that this ability should not still be extant in at least a few species. No such organisms have been found. On the other hand, it is possible that the genetic capacity is masked. In order to synthesize the cell membrane "from scratch", it must first be removed. To do so would result in the death of the cell before their synthetic capacity could be demonstrated. However, were this the case, then at least some cells should be able to synthesize internal membranes without resorting to such intricate systems such as the Golgi to release membrane-bound organelles.

In contrast with those biologists who recognize the membrane as a refined product of evolution on the molecular level, there are a number of scientists who attempt to explain the similarity and universality of biomembranes in terms of its possible morphological role in prebiological development. In this case, the membrane is a motive force in the development of living organisms, rather than a result thereof.

there is the alternate view

The direct involvement of membranes in the course of biogenesis is based upon current observations of the behaviour of amphipathic molecules (such as long chain alcohols, fatty acids, polar lipids) in aqueous solution.[1] Although these polar hydrocarbon molecules are not miscible in water and tend to form layers on the surface, upon shaking they disappear into solution. Microscopic examination reveals that for thermodynamic reasons, the molecules arrange themselves in closed bimolecular layer bags, known as vesicles. These vesicles, composed of simple molecules, bear close resemblence to those which are formed by lipid mixtures extracted from cell membranes. Both varieties of these artificial vesicles are capable of adsorbing membrane proteins.

Oparin's hypothesis that life began in a primeval sea, rich in organic molecules which were synthesized in the then-reducing atmosphere, and subsequently dissolved, still remains the best theory of chemical evolution. Oparin further postulates that the morphological distinction between pre-living systems and the environment began with the development of coacervates, or globules of gelled protein and starch, while perhaps chemically feasible, has no basis in biology. Where can we see the biological results of this form? Even the most primitive blue green algae and photosynthetic bacteria have a very fluid cytoplasm, and a biological membrane, not a phase boundary, separates them from solution. It would seem more rational to postulate that a primitive lipid-protein vesicle was life's first bag.

The creation of these vesicles in saline solution, or in an organic soup, immediately differentiates between the solution within and that without. This could have led to an increasing disparity between concentration and chemical species within the vesicle and without. Eventually some primitive metabolism may have developed, involving simple self-catalysingreactions.

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If primitive cells were first contained in a spontaneously forming membrane, perhaps they developed only the capacity to synthesize lipids, and later membrane proteins, and incorporate them into existing membrane structures. In this case, cells were never able to synthesize a membrane de novo. On the other hand, as cells began to incorporate specific lipid and protein moieties into the membrane, its composition and properties may have undergone quite a transformation. The bacteria Mycoplasma Laidlawii can both synthesize membrane lipids from simple precursors or incorporate lipids supplied extraneously into the membrane without metabolizing them. Thus, the membrane composition can be radically altered without adversely affecting the viability of the microorganism. And this is likely what occurred.

We will never know for certain whether the cell or the membrane came first. Perhaps neither is entirely correct. Whatever the case, the conclusion is that to talk of cell constituents solely in terms of their function in the cell may be both irrelevant and misleading. For if the membrane (or some primitive form thereof) is as old, or older, than life itself, one could just as easily reconcile cell structure and function in terms of the membrane, as vice-versa.

Explanation of terms:

erythrocyte- red blood cell

Pinocytosis- process in which cell membrane engulfs external liquid and brings it into the cell as a membrane enclosed vacuole

Phagocytosis- The similar ingestion of solid particles.

Flagellae- a simple organelle responsible for motility in microorganisms

Amphipathic- containing both polar and non-polar groups